

## REMARKS

Claims 1-31 are pending.

Claims 32-46 have been canceled, without prejudice. Applicants expressly reserve the right to file a divisional application including those claims.

### Elections/Restrictions

— The Examiner states that Claims 9 and 10 do not read-on the elected species of Figure 7. This statement is traversed as applied to Claim 10.

Claim 10 recites that the means for determining a value of voltage at the load includes means for remotely communicating the value of voltage at the load to the means for determining a value of the arc fault energy. *See, e.g.*, page 15, line 11 through page 16, line 3 of the specification; and Figure 7. The apparatus 130 includes a detection module 134 and a remote load voltage sensor 136, which measures a value of voltage,  $V_{LOAD}$ , at the load 18. The detection module 134 includes the source current sensor 24, which measures a value of the source current 4 flowing in the power circuit 132 to or from the power source 16 (*e.g.*, an AC or DC power source), and a suitable processor, such as microprocessor ( $\mu$ P) 138. The remote load voltage sensor 136 includes a suitable precision switched resistor 140 having a resistance,  $R_{PRE}$ , a switch 142, and an electronic switch oscillator 144, which encodes the load voltage as a current 145 through a power line carrier current signal 146. The detection module 134 also includes a demodulator 148, which demodulates the current 145,  $I_{DEMODULATED}$ , from the power circuit 132, and which, thus, decodes the load voltage,  $V_{LOAD}$ , from Equation 8, assuming that the switch 142 has a suitably low impedance.

For the above reasons, it is submitted that Claim 10 reads, for example, on the elected species of Figure 7.

The Examiner further states that Claims 9 and 10 are withdrawn from further consideration under Rule 142(b) as being drawn to a non-elected species, there being no allowable generic or linking claim. This statement is traversed.

For reasons as are discussed below in connection with the Section 103(a) rejections, Claim 1 is allowable. This claim is generic to the claimed species of Figures 6 and 7. Claim 9 reads on the species of Figure 6 and is written in dependent form. *See* 37 CFR 1.141(a). Claim 10 reads, for example, on the elected species of Figure 7.

Hence, for the above reasons, it is submitted that Claims 9 and 10 should be considered by the Examiner.

**Rejections under 35 U.S.C. § 103(a)**

Claims 1-3 and 11 are rejected on the ground of being unpatentable over U.S. Patent No. 5,986,860 (Scott) in view of U.S. Patent No. 6,736,944 (Buda).

Scott discloses methods for zone arc protection to detect series and/or shunt arcing faults in various electrical components and/or circuits. Series arcs are detected using a voltage drop system or a line power loss system. Figure 14 of Scott shows a circuit 135 for use in a line power loss (arc power) method of arc-detection. This method monitors the power loss through a conductor and subtracts out the energy due to resistance. The arc power relates more directly to the potential for equipment damage and other problems, than do other measurements such as arc voltage or arc current alone. The pilot wires or connections 126 and 130 of Figure 13 of Scott supply the line drop voltage to an arc power sensor type of arc detector circuit 132. A current transformer sensor 134 supplies the current in the line from the source end of the line to the arc power sensor 132. Thus, the current times the total voltage drop may be calculated by the arc power sensor 132 to determine the arc power in the presence of an arcing voltage  $V_{arc}$  in similar form to the arcing voltage indication of Figure 13 of Scott. With this circuit 135 and approach, an inverse time trip curve could be utilized, allowing components such as breakers and fusers to have large operating arc power for a few milliseconds, while conductors and connections would be allowed little or no arc power.

Figure 3 of Scott shows a zero-sequence voltage differential arc detection system. The arc detector 70 comprises comparing means for comparing the two zero-sequence voltages, that is, the respective sums of the voltages on the pilot wires from the load end and source end of the line. The currents in the phase conductors will sum to zero anywhere in the zone. The voltage drops and mutually induced voltages also sum to zero for wiring systems with similarly shaped phase conductors. The current-carrying conductors have similar electrical properties and similar mutual couplings between all phase conductors.

Buda discloses (Figure 1) an arc detection arrangement 100 used in a pressure vapor deposition (PVD) process step in integrated circuit manufacture and other processes where uniform material deposition is desired. A PVD sputtering system includes a deposition (vacuum) chamber 10 containing a gas 15, such as argon, at low pressure. A target 20 formed of metal is placed in vacuum chamber 10 and electrically coupled as a cathode to a power supply 30 via an independent power supply interface module (PSIM) 40. The power supply 30 and chamber 10 are coupled using a coaxial interconnecting cable 35.

Buda discloses (col. 4, ll. 10-22) that in a PVD process used to produce integrated circuits, arcing conditions lasting less than 1 microsecond are commonly observed.

These short duration arcs are commonly called microarcs. Electronically controlled analog or switching power supplies cannot react to this rapid change in chamber impedance during a microarc. As a natural consequence of the series inductance, the power supply delivers a near constant current to the chamber during a microarc. Assuming that during an arcing condition, all energy delivered by the power supply is focused on the arc, the energy delivered to an individual arc can be estimated by the integral of the product of the power supply voltage times the (assumed constant) current over the interval of the arc.

Buda further discloses (col. 9, ll. 2-21) that an arc detection arrangement is adapted to measure arcing energy responsive to comparing a power-related parameter to at least one threshold, arcing energy being proportional to the product of the arcing duration and the arcing intensity, and assessment of arcing severity being a function of the arcing energy (i.e., the product of arcing intensity and arcing duration). According to one particular implementation, a plurality of thresholds are used to determine a plurality of durations, in order to estimate (i.e., approximate, or integrate) an area bounded by a power-related parameter (e.g., chamber voltage) versus time plot during a depression in the voltage due to arcing. An arcing energy proportional to the bounded area for each arcing event is used to assess the severity of arcing. According to a further implementation, the arc detection arrangement is further adapted to accumulate arcing energy over a plurality of arcing events, for example by summing the products of arcing intensity and arcing duration to assess the severity of arcing.

Buda also discloses (col. 26, ll. 37-51) that DSPC 630 (Figure 6) samples four ADLU register sets at a 10 kHz rate and communicates the arc count and arc time count for all four channels via High Speed Communication Interface 70 to Logic Arrangement 60. DSPC 630 also samples and transfers the nominal, filtered chamber current  $I_{CH}$  and filtered chamber voltage  $V_{CH}$  to Logic Arrangement 60, which performs the mathematical operations required to resolve the arc and compute an estimate of arc energy. The DSPC 630 performs the computations internally, transmitting the resulting estimate of arc related parameters, such as arc time at each threshold value, and estimated arc energy to Logic Arrangement 60. The signal  $V_{CH}$  is a band-limited, single-ended version of the differential signals VPSIM+ and VPSIM-, developed by Vsense circuit 250 of PSIM 40 (Figure 1 of Buda).

Claim 1 recites, *inter alia*, an apparatus for determining arc fault energy in real time for a power circuit between a power source and a load comprising: means for determining a value of voltage at the load; means for determining a value of current flowing

in the power circuit to or from the power source; and means for determining a value of the arc fault energy from the value of voltage and the value of current.

The Examiner states that Scott does not disclose any means for determining a value of arc fault energy from the recited value of voltage and the recited value of current.

The Examiner also states that Buda (col. 9, ll. 2-9) discloses "means for determining a value of the arc fault energy from the value of voltage and the value of current". This statement is traversed as applied to the refined recital of Claim 1. The portion of Buda relied upon by the Examiner has nothing to do with any current. Instead, energy of a chamber arc is determined from the product of arcing intensity and arcing duration. *See, also, Buda*, col. 9, ll. 56-67.

The Examiner further states that this recited element of Claim 1 is "well known in the art". This statement is traversed. Since Buda has been dealt with, the Examiner is requested to cite a reference within the context of Applicants' claims in support of this statement.

It is submitted that the teachings of Scott and Buda could not be combined without great difficulty. There is no teaching or suggestion in Buda of any "arc fault" as is understood by those of ordinary skill in the art. Hence, it is submitted that Buda is non-analogous art, which is not directed to the particular problem of determining arc fault energy. At best, Buda teaches or suggests estimating energy delivered to an individual arc of a chamber by the integral of the product of power supply voltage times the (assumed constant) current over the interval of such arc, or estimating energy of such arc from a filtered chamber current ( $I_{CH}$ ) and filtered chamber voltage ( $V_{CH}$ ) that is measured by PSIM 40 (Figure 1) upstream of chamber 10 and upstream of the chamber end of cable 35. Accordingly, Buda adds nothing to Scott regarding the recited means for determining a value of *arc fault* energy from the recited value of voltage *at a load* and the recited value of current.

Accordingly, for the above reasons, it is submitted that Claim 1 patentably distinguishes over the references.

Claims 2 and 3 depend directly or indirectly from Claim 1 and patentably distinguish over the references for the same reasons.

Claim 2 is not separately asserted to be patentable except in combination with Claim 1 from which it depends.

Claim 3 is not separately asserted to be patentable except in combination with Claim 2 (and Claim 1) from which it depends.

Claim 11 is an independent claim which recites, *inter alia*, a method for determining arc fault energy in real time for a power circuit between a power source and a load comprising: determining a value of voltage at the load; determining a value of current flowing in the power circuit to or from the power source; and determining a value of the arc fault energy from the value of voltage and the value of current.

The Examiner states that Scott does not disclose determining a value of arc fault energy from the recited value of voltage and the recited value of current.

The Examiner also states that Buda (col. 9, ll. 2-9) discloses “determining a value of the arc fault energy from the value of voltage and the value of current”. This statement is traversed as applied to the refined recital of Claim 11. The portion of Buda relied upon by the Examiner has nothing to do with any current. Instead, energy of a chamber arc is determined from the product of arcing intensity and arcing duration. *See, also, Buda*, col. 9, ll. 56-67.

The Examiner further states that this recited element of Claim 11 is “well known in the art”. This statement is traversed. Since Buda has been dealt with, the Examiner is requested to cite a reference within the context of Applicants’ claims in support of this statement.

It is submitted that the teachings of Scott and Buda could not be combined without great difficulty. There is no teaching or suggestion in Buda of any “arc fault” as is understood by those of ordinary skill in the art. Hence, it is submitted that Buda is non-analogous art, which is not directed to the particular problem of determining arc fault energy. At best, Buda teaches or suggests estimating energy delivered to an individual arc of a chamber by the integral of the product of power supply voltage times the (assumed constant) current over the interval of such arc, or estimating energy of such arc from a filtered chamber current ( $I_{CH}$ ) and filtered chamber voltage ( $V_{CH}$ ) that is measured by PSIM 40 (Figure 1) upstream of chamber 10 and upstream of the chamber end of cable 35. Therefore, Buda adds nothing to Scott regarding the recited determining a value of *arc fault* energy from the recited value of voltage *at a load* and the recited value of current.

Hence, for the above reasons, it is submitted that Claim 11 patentably distinguishes over the references.

#### Objections to the Claims

The Examiner states that Claims 4-8 and 12-15 are objected to as depending from a rejected based claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claim.

Claims 4-8 depend directly or indirectly from Claim 1. Since the rejection of Claim 1 under Section 103(a) has been dealt with, it is submitted that Claims 4-8 are in proper form for allowance.

Claims 12-15 depend directly or indirectly from Claim 11. Since the rejection of Claim 11 under Section 103(a) has been dealt with, it is submitted that Claims 12-15 are in proper form for allowance.

**Allowable Subject Matter**

It is noted with appreciation that the Examiner states that Claims 16-31 are allowed.

**Summary and Conclusion**

The prior art made of record and not relied upon but considered pertinent to Applicants' disclosure has been reviewed. In summary, it is submitted that Claims 1-31 are patentable over the references of record. Reconsideration and early allowance are requested.

Respectfully submitted,



Kirk D. Houser  
Attorney for Applicants  
Registration No. 37,357

(412) 566-6083